

# I. PATENT ABSTRACTS OF JAPAN

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(71)Applicant : **MITSUBISHI MOTORS CORP**

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(72)Inventor : **ISHIDA TETSURO**

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## (54) METHOD OF CHANGING COMPRESSION RATIO OF ENGINE

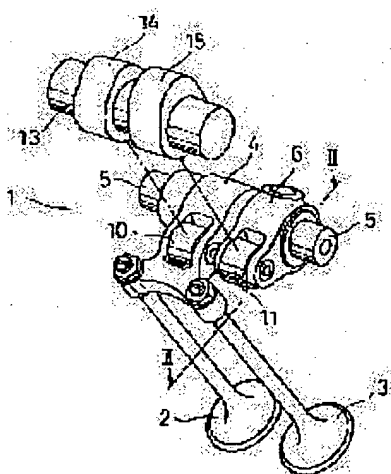
(57)Abstract:

**PURPOSE:** To provide a compression ratio suitable for a drive state by shortening an effective compression process by way of opening air intake valves in the middle of compression process by means of delaying a valve opening time of the air intake valves of a high compression ratio engine.

**CONSTITUTION:** A movable valve system 1 is constituted of a high compression ratio rocker arm 4 and a low compression ratio rocker arm 6 to drive air intake valves 2, 3, a high compression ratio cam 14 and a low compression ratio cam 15 provided with a relay piston and a cam shaft 13 to connect and disconnect the high and the low compression ratio rocker arms 4, 6 and others. In case of changing from a high compression ratio to a low compression ratio, the relay piston is pushed out by hydraulic pressure, and the low compression ratio rocker arm 6 is integrally connected to the high compression ratio rocker arm 4. Thereby, opening of the air intake valves 2, 3 by the high compression ratio cam

14 is finished in compression process, but the air intake valves 2, 3 are still kept open by the low compression ratio cam 15. Consequently, compression pressure is drawn out and does not rise but falls.

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## CLAIMS

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### [Claim(s)]

[Claim 1] How to change the compression ratio of the engine characterized by making clausilium timing of an intake valve late, carrying out clausilium in the middle of a compression stroke when using a high compression ratio engine as the base and changing it from a high compression ratio to a low compression ratio, shortening an effective compression stroke, and making a compression ratio low.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Industrial Application] This invention relates to the approach of changing an engine compression ratio.

#### [0002]

[Description of the Prior Art] In order to improve combustion efficiency of the gaseous mixture which made [ many ] the inhalation air content in the internal combustion engine which uses a gasoline as a fuel and to obtain a high output, it is making a compression ratio as high as possible, but if a compression ratio is made high, it becomes easy to generate knocking and cannot be made not much high. On the other hand, the methanol as an alternate fuel can be made a high compression ratio that it is hard to knock. Moreover, in order to improve fuel consumption of a partialness field also in the case of a gasoline, in low rotation and a low load field, it is desirable to consider as a high compression ratio and to consider as a low compression ratio in the heavy load field which a knock tends to generate.

[0003] Then, many adjustable compression ratio engines of various kinds of structures which can change a compression ratio according to the class of fuel used from the former, corresponding to engine operational status are proposed. It is promising in points, such as correspondence to the formation of a fuel octane in reduction of the fuel consumption by forming an engine partialness field into a high compression ratio, a variety fuel (FFV), etc., and improvement in the engine performance of the partialness field of a supercharged engine, to carry out adjustable [ of the engine compression ratio ], as mentioned above, and completion of the system is expected.

#### [0004]

[Problem(s) to be Solved by the Invention] However, all have the device and very complicated structure, cost becomes very high there are not only many elements

unsuitable for high-speed rotation, but, and, moreover, the present condition of the conventional adjustable compression ratio engine is not putting the compression ratio in practical use by there being few merits made adjustable, since there are problems, like practicality and dependability being missing.

[0005] In having made this invention in view of the above-mentioned point, using a high compression ratio engine as the base and making it a low compression ratio, it aims at offering the approach of changing the compression ratio of the engine which delays the clausilium timing of an intake valve, is made carrying out clausilium in the middle of a compression stroke, and was made to make a real compression ratio low.

[0006]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to this invention, when using a high compression ratio engine as the base and changing it from a high compression ratio to a low compression ratio, clausilium timing of an intake valve is made late, clausilium is carried out in the middle of a compression stroke, an effective compression stroke is shortened, and it is made to make a compression ratio low.

[0007]

[Function] The engine of the base is made into a high compression ratio, and in operating in the condition as it is in operating the engine concerned as a high compression ratio, and changing into a low compression ratio, the clausilium timing of an intake valve is delayed and it carries out clausilium in the middle of a compression stroke. Thereby, an engine compression ratio falls. As for modification of this compression ratio, it is possible to make it change according to the operational status of the engine concerned during operation of an engine.

[0008]

[Example] One example of this invention is explained in full detail based on an accompanying drawing below. Drawing 1 and drawing 2 show the valve gear of the inspired air flow path of the engine for enforcing this invention approach. A valve gear 1 The rocker arm 4 for the high compression ratios for driving intake valves 2 and 3 (henceforth a "high compression ratio rocker arm"), The rocker arm 6 for low compression ratios (henceforth a "low compression ratio rocker arm"), It is constituted by the high compression ratio cam 14 and low compression ratio cam 15 grade which were prepared in the relay piston 7 which intervenes between the high compression ratio rocker arm 4 and the low compression ratio rocker arm 6, and combines these both, or cancels association, and the cam shaft 13.

[0009] Rocker shafts 5 and 5 are formed in the both sides of a nothing end face in the abbreviation T mold at one, and, as for the high compression ratio rocker arm 4, oil path 5a is installed through the axis. These rocker shafts 5 and 5 are supported to revolve by the rocker shaft journals 12 and 12 pivotable, and oil pressure P is supplied to a relay piston 7 from the oil pressure control circuit which oil path 5a is opened for free passage

by the oil paths 12a and 12a established in journals 12 and 12, and is not illustrated.

[0010] Moreover, boss 6a of a end face is attached outside rotatable by the rocker shaft 5 by the side of one of the high compression ratio rocker arm 4, and the low compression ratio rocker arm 6 is supported rockable to the high compression ratio rocker arm 4 concerned. And in contact with the high compression ratio cam 14 of a cam shaft 13, and the low compression ratio cam 15, the roller bearings 10 and 11 which can roll are formed at the center of abbreviation of these high compression ratio rocker arms 4, and the tip of the low compression ratio rocker arm 6.

[0011] The piston holes 5b and 5c are drilled in the diameter direction in the said alignment by the fitting section into which the low compression ratio rocker arm 6 of the rocker shaft 5 by the side of one of the high compression ratio rocker arm 4 fits, and one piston hole 5b is made into the aperture on which a relay piston 7 can slide, and let piston hole 5c of another side be a major diameter more slightly than piston hole 5b. And these piston holes 5b and 5c make a level difference like illustration, and are formed successively in the part of central oil path 5a.

[0012] The die length is slightly set up short rather than the diameter of a rocker shaft 5, and, as for the relay piston 7, flange 7c is prepared in end face 7b. This relay piston 7 is fitted in the piston holes 5b and 5c of a rocker shaft 5, and Spring-8 is \*\*\*\*(ed) by piston hole 5c between a level difference side with piston hole 5b, and flange 7c. And the relay piston 7 is drawn by the spring force of Spring-8 in piston hole 5b of a rocker arm 5, and 5c.

[0013] On the other hand, piston hole 6b is drilled in piston hole 5b of a rocker shaft 5, and the predetermined part which counters by the end face of the low compression ratio rocker arm 6 radial. Let this piston hole 6b be the magnitude into which tip 7a of a relay piston 7 can fit. If oil pressure P is supplied to oil path 5a of a rocker shaft 5, this relay piston 7 will resist the spring force of Spring-8, will be extruded from piston hole 5b, and that tip 7a fits into piston hole 6b of the low compression rocker arm 6, and it combines the low compression rocker arm 6 concerned with the high compression ratio rocker arm 4.

[0014] The high compression ratio cam 14 and the low compression ratio cam 15 are formed as shown in drawing 3, and the low compression ratio cam 15 is formed in the configuration which made clausilium timing late and shifted to the compression stroke side during the predetermined period rather than the high compression ratio cam 14. That is, the high compression ratio of the engine concerned is a base (base), and the low compression ratio cam 15 makes intake valves 2 and 3 open to the middle of a compression stroke, and extracts the compression pressure in a cylinder from these intake valves 2 and 3. Thereby, an effective compression stroke becomes short and the engine concerned can be changed into a low compression ratio from a high compression ratio.

[0015] By the way, since it is easy to knock in using a gasoline generally as a fuel, a

compression ratio cannot be made not much high, but a compression ratio can be made high, when mixing ethanol etc. to a gasoline or using these fuels that an octane value cannot knock [ therefore ] at fuels, such as a methanol as an alternate fuel, easily highly. Then, as shown in drawing 4 , when a fuel uses a fuel with many rates of a gasoline or a gasoline, it is made a low compression ratio, and when there are many rates of a methanol, it is made a high compression ratio. That is, correspondence in change of the fuel octane value in a variety fuel (FFV) etc. is enabled.

[0016] Moreover, as shown in drawing 5 , when an engine is in the operating range ( $>La$ ) of a heavy load, it considers as a low compression ratio, and when it is in the operating range of low-speed rotation ( $<Na$ ) and a low load ( $<La$ ), it becomes possible by considering as a high compression ratio to aim at improvement in the engine performance in a partialness field. Therefore, the class of fuel to be used, an engine speed, Control the oil pressure  $P$  which detects an engine load etc., respectively and is supplied to oil path 5a of the high compression ratio rocker arm 4 of drawing 1 with an electronic control (neither is illustrated), and intake valves 2 and 3 are driven only by the high compression ratio rocker arm 4 with a relay piston 7. Or intake valves 2 and 3 are made to drive through the high compression ratio rocker arm 4 by the low compression ratio rocker arm 6, and the compression ratio of the engine concerned is changed to a high compression ratio or a low compression ratio. It enables this to change to a high compression ratio or a low compression ratio during operation of an engine.

[0017] An operation is explained below. First, the case of a high compression ratio where it becomes the base is explained. As shown in drawing 6  $R > 6$  at the time of a high compression ratio, oil pressure is not supplied to oil path 5a of the rocker shaft 5 of the high compression ratio rocker arm 4, therefore a relay piston 7 is drawn by the spring force of Spring-8 in piston hole 5b of the rocker shaft 5 concerned, and 5c, and, as for the valve gear 1, association with the low compression ratio rocker arm 6 is canceled.

[0018] If a cam shaft 13 ( drawing 1 ) rotates in this condition, the high compression ratio cam 14 will drive the high compression ratio rocker arm 4, and closing motion control of the intake valves 2 and 3 will be carried out. On the other hand, even if the low compression ratio cam 15 rotates, the low compression ratio rocker arm 6 is only rocked by the low compression ratio cam 15 concerned to the rocker shaft 5 of the high compression ratio rocker arm 4, and does not participate in the drive of intake valves 2 and 3 at all. Therefore, intake valves 2 and 3 will be driven only by the high compression ratio rocker arm 4.

[0019] As a compression stroke is shown in drawing 8 (a) - (c), clausilium of an intake valve 2 and the exhaust air bulb 22 (respectively piece illustration) is carried out, it follows on a piston 20 going up from a bottom dead point (BDC), the gaseous mixture in a cylinder 21 is compressed gradually, and the compression volume serves as min in a top dead center (TDC). And the compression volume of the cylinder 21 at the time of

this high compression ratio serves as max, as the slash of drawing 8 (d) shows. Drawing 10 and drawing 11 show the valve timing and the valve-lift curve which can be set like -exhaust air line like the inhalation-of-air line of the engine concerned.

[0020] Now, in changing an engine compression ratio into a low compression ratio from an above-mentioned high compression ratio, said electronic control operates an oil pressure control circuit (not shown), and supplies oil pressure P to oil path 5a of the high compression ratio rocker arm 4. If oil pressure P is supplied to oil path 5a, as shown in drawing 7, a relay piston 7 will resist the spring force of Spring-8, and will be extruded, and the tip 7a will fit into piston hole 6b of the low compression ratio rocker arm 6. Thereby, the low compression ratio rocker arm 6 concerned is combined with the high compression ratio rocker arm 4 in one.

[0021] In the compression stroke, as shown in drawing 9 (a), when a piston 20 is in a bottom dead point (BDC) location, an intake valve 2 is in the condition that the high compression ratio cam 14 still opened, and, on the other hand, clausilium of the exhaust air bulb 22 has already been carried out. Although valve opening of the intake valves 2 and 3 by the high compression ratio cam 14 is ended with a rise of a piston 20 and compression of a cylinder 21 is started, the low compression ratio cam 15 is making intake valves 2 and 3 still open succeedingly. Consequently, as shown in drawing 9 (b), the compression pressure in a cylinder 21 falls out from intake valves 2 and 3 like an arrow head, and the compression pressure of the cylinder 21 concerned cannot rise.

[0022] If clausilium is carried out with rotation of the low compression ratio cam 15 as intake valves 2 and 3 are compression strokes, compression will be started, and as shown in drawing 9 (c), when a piston 20 reaches a top dead center (TDC), the compression volume serves as min. And as compared with the time of the high compression ratio which comes to show the compression volume of the cylinder 21 concerned at this time with a slash to drawing 9 (d), and is shown in said drawing 8 (d), an effective compression stroke becomes short, and that volume becomes small.

Consequently, the real compression ratio of a cylinder 21 becomes low.

[0023] As intake valves 2 and 3 are shown in drawing 10  $R > 0$  at the time of a low compression ratio, period valve opening of predetermined [ to clausilium stage IC' at the time of Stage IC - a low compression ratio ] is carried out at the time of the clausilium at the time of a high compression ratio, and the compression pressure in a cylinder is discharged between the predetermined periods concerned. Moreover, a dotted line shows the valve-opening period of the intake valves 2 and 3 at the time of the low compression ratio concerned to drawing 11. The continuous line of drawing 12 comes to show the cylinder internal pressure-cylinder capacity (P-V) property of the engine concerned at the time of this low compression ratio. In addition, the part shown with the drawing 2 middle point chain line shows the property at the time of the usual high compression.

[0024] in addition, the inside of drawing 10 and Sign IO -- the valve-opening stage of an

intake valve -- IC -- the clausilium stage at the time of the high compression ratio of intake valves 2 and 3 -- in IC', EO shows the valve-opening stage of an exhaust air bulb, and EC shows the clausilium stage of the exhaust air bulb concerned for the clausilium stage at the time of the low compression ratio of these intake valves 2 and 3.

[0025]

[Effect of the Invention] Since according to this invention delay the clausilium stage of an intake valve and clausilium is carried out in the middle of a compression stroke, as explained above, an effective compression stroke is shortened and it was made to make a compression ratio low, it is possible to change a compression ratio to a high compression ratio or a low compression ratio simply according to the operational status of the engine concerned during operation of an engine. moreover, it is possible for the structure of a change of an engine compression ratio to become easy, and for increase-ization of weight to be suppressed in connection with this, to be secured good, when combustion is a high compression ratio and any of a low compression ratio, in order not to change the configuration of a combustion chamber moreover, and to deal also with high-speed rotation -- etc. -- there is outstanding effectiveness.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the perspective view showing one example of the valve gear for enforcing the approach of changing the compression ratio of the engine concerning this invention.

[Drawing 2] It is a sectional view in alignment with arrow II-II of drawing 1 .

[Drawing 3] It is drawing showing the configuration of the high compression ratio cam of drawing 1 , and a low compression ratio cam.

[Drawing 4] It is the graph which shows the relation of the fuel and compression ratio to be used.

[Drawing 5] It is the graph which shows the relation of the compression ratio to an engine rotational frequency and an engine load.

[Drawing 6] It is drawing showing the condition at the time of the high compression ratio of the valve gear of drawing 2 .

[Drawing 7] It is drawing showing the condition at the time of the low compression ratio of the valve gear of drawing 2 .

[Drawing 8] It is the explanatory view showing the compression stroke of the cylinder at the time of a high compression ratio.

[Drawing 9] It is the explanatory view showing the compression stroke of the cylinder at the time of a low compression ratio.

[Drawing 10] It is the explanatory view showing one example of the valve timing in this invention approach.

[Drawing 11] It is the property Fig. showing one example of the valve-lift curve in this invention approach.

[Drawing 12] It is the graph which shows one example of the P-V property of the engine in this invention approach.

[Description of Notations]

1 Valve Gear

2 Three Intake valve

4 High Compression Ratio Rocker Arm

5 Rocker Shaft

6 Low Compression Ratio Rocker Arm

7 Relay Piston

8 Spring

13 Cam Shaft

14 High Compression Ratio Cam

15 Low Compression Ratio Cam

20 Piston

21 Cylinder

22 Exhaust Air Bulb

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[Translation done.]